



Methodology for Integrating Risk Mitigation Activities into JCL Analysis

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1.0 Overview

The intent of this whitepaper is to provide clarification and guidance for methodologies pertaining to capturing risk mitigation cost and schedule activities within NASA's Joint Confidence Level (JCL) analysis process. These methodologies are not solely limited to NASA's JCL process and should be incorporated in Programmatic and risk assessments, probabilistic risk analysis and developing cost/schedule range estimates. These methodologies are intended to assess and compare effectiveness mitigation strategies for effective resource allocation.

1.1 Background

The JCL process is intended to provide NASA stakeholders at the Agency level the ability to make risk-informed decisions for Programs/projects (P/p) with a lifecycle cost of \$250M or greater. JCL models are created utilizing cost-loaded schedules to integrate and model the impacts of uncertainty and risk(s). A JCL helps set the foundation to answer fundamental questions such as: does the project have enough funds, can the project meet the schedule, what are the areas of risk toward successful execution of the project, and what risk mitigation strategies provide the best project benefit?

In summary, NASA Procedural Requirements (NPR) 7120.5E, directs projects to generate a probabilistic cost-loaded schedule and produce a JCL for Key Decision Point (KDP) I/C that is executable within the available annual resources. This JCL analysis will be evaluated by a non-advocacy body. The Decision Authority will decide the JCL (probability) for the associated development and life-cycle cost at which the Agency commits to deliver the P/p. It is recommended the JCL value be at 70% with a minimum value of 50%.

As with any process/procedural requirement, there may be flaws or points of contention and the current JCL process is no exception. One of the main points of contention from P/p's is the JCL analysis does not take into account effort underway and/or planned to mitigate potential risks and uncertainties from happening. Push back from P/p's is focused on the JCL solely looking at worse case scenarios and "make things look worse" than what is going on. In some cases P/p's have incorporated minimal (in some cases zero) uncertainty and risk impacts on the grounds that mitigation activities eliminate the probability of a risk/uncertainty from occurring.

While there is some validity to these concerns, minimizing and/or omitting risk and uncertainty from the analysis, it is not completely valid. In several cases when a P/p has taken this approach, they forget to incorporate a key part of taking credit for risk mitigation. Often times cost and/or schedule activities associated with risk mitigation efforts are not captured within the P/p's baseline budget and/or IMS, let alone captured within JCL models. This whitepaper will discuss how and why mitigation activities must be incorporated into the analysis, as well as how this can be useful for completing the analysis of mitigation effectiveness.



1.2 Risk and Mitigation Management

The overall intent of robust risk management is to proactively identify potential cost, schedule, technical and capability threats a P/p may face on their path to achieving mission success. The most important aspect is not the identification of risks, but developing and implementing mitigation plans to avoid or reduce the impact of a risk should it occur when applicable. There are some instances where all a P/p can do is accept the risk if it occurs and have plans in place to minimize the impact of a risk occurrence. In order for a P/p to mitigate the likelihood of occurrence and/or the impact of a risk that is realized, resources must be obligated. These resources are often obligated in terms of management reserve funds for additional personnel, test equipment, facilities, test procedures, etc., all of which incur cost and additional time for completion.

When a mitigation plan is implemented, the costs associated for these efforts should be captured within the P/p cost estimate at the WBS level. The work performed and the associated cost to complete a mitigation activity should be reduced from management reserve. It would be beneficial to create a separate WBS line item within the specified WBS element to track the mitigation costs.

At the same time, mitigation activities should be captured within the IMS and properly linked within the WBS element to which associated costs are assigned. All activities associated with the mitigation effort must be incorporated to track the progress. Per NASA NPR 8000.4A, mitigation effort pertaining to Continuous Risk Management (CRM) – “Ensure that risk management activities of the organizational unit support, and are consistent with, ongoing internal control activities defined in NPD 1200.1 (Requirement 59267).”

The importance of the two steps just mentioned is not solely for completing the JCL process, but is key to successful program management. Mitigation effort is constantly overlooked, but routinely the mitigation efforts grow and exceed original time and cost commitments. This directly correlates to cost and schedule overruns incurred by a P/p.

1.3 Post-Mitigated Risk (Residual Risk)

The overall objective of risk mitigation activities is to avoid the consequence of a risk impacting the P/p or reduce the likelihood of occurrence. In most cases risk mitigation activities will reduce the likelihood of risk occurrence, but if the risk is realized the level of consequence impact remains. If the risk is not fully avoided or mitigated, the remaining probability of the risk occurring is known as post-mitigated or residual risk.

When factoring in mitigation progress into the JCL analysis, the post-mitigated risk factors need to be incorporated into the analysis models. The reason for capturing the post-mitigated risk is because if a risk does not become fully mitigated or OBE (Overcome by Events), there is still a chance the risk could impact a project. Fully omitting post-mitigated risk from a JCL analysis would optimistically skew overall results.



One area of caution when integrating post-mitigated risk in lieu of current risk ratings is that simply capturing post-mitigated risk values assumes mitigation efforts will be successful, but there is uncertainty surrounding mitigation effectiveness and that mitigation effort does not fully resolve the risk identified. Risk ratings captured within a P/p risk database system should be current with ratings reflecting mitigation efforts to date. Each successful mitigation step should in theory reduce the likelihood of risk occurrence, and in some cases the impact may be reduced as well.

2.0 Integration into JCL Models

2.1 Capturing Mitigation Efforts

To manage risk mitigation effectively a P/p, all resources, cost and timeline associated with a mitigation plan should be well documented and captured within the P/p budget and Integrated Master Schedule (IMS). This is the first step towards incorporating and taking credit for mitigation effectiveness within a JCL model. Lack of identified resources and efforts captured within P/p baseline often indicates mitigation is not being actively managed and would be a point of contention for an independent assessment team to question with regard to validity of risk assessment/mitigation within a JCL analysis model.

Uncertainty would still be applied within the JCL model by WBS element and reflective of the current state of the P/p. Because uncertainty reflects unknown-unknowns, versus risks that reflect know-unknowns, mitigation efforts of risks do not apply to uncertainty. Risk mitigation efforts relate to minimizing the effects of a potentially known threat events which carry a variable unknown impact. Uncertainty strictly pertains to unknown threat events which carry an unknown variable impact. Historically analogous data exists to help P/p's plan and document JCL Uncertainty.

Properly capturing risk mitigation within a JCL model is a two-step process. First is to ensure costs and timelines associated with mitigation efforts are captured and clearly identified within cost estimates and IMS. As most JCL models are constructed utilizing a summary analysis schedule, it is recommended to capture all mitigation task activities into a single task activity that spans the total timeframe of the mitigation effort. The cost associated with the effort should be captured within the mitigation task accordingly in a time-dependent (TD) and time-independent (TI) costing framework. TD costs are resources such as labor where cost is directly dependent on length of time. TI costs are resources such as additional material procurements, additional test facilities, etc., where time does not affect total cost. Mitigation tasks are not immune from uncertainty; therefore a range estimate in terms of Min/Most Likely/Max values should be established for both cost and duration of a mitigation activity. Understanding the level of complexity of the risk and mitigation efforts helps to frame potential uncertainty surrounding estimation efforts. The more complex a risk root cause is, coupled with a lower fidelity surrounding mitigation efforts would drive a higher uncertainty pertaining to resource (Cost and schedule) range estimation.



The second step is to capture post-mitigated risk within the model. As with the current JCL model development process of capturing likelihood of occurrence and consequence of impact, capturing post-mitigated risk is no different. The only difference is the values for post-mitigated risks are based on successful mitigation efforts, versus the likelihood and consequence of risks in their current state.

2.1 Mitigation Effectiveness Analysis

A mitigation effectiveness analysis can provide beneficial insight to a P/p with regard to how much risk could be burned down through successful mitigation activities. This can be valuable in understanding if a P/p is utilizing management reserve resources in the most efficient way. Another way to look at this is to ask "Are we (the P/p) spending \$5 to mitigate a \$3M problem or are we spending \$3M to mitigate a \$5 problem?"

While this is not a requirement for the JCL process, it is a good program management activity to help give insight to P/p stakeholders as to how much risk/uncertainty impacts the P/p is facing in contrast to the value of risk minimized through effective mitigation.

Mitigation effectiveness analysis is done in three steps utilizing similar JCL models. The first model would contain only uncertainty to understand how uncertainty impacts affect a P/p in terms of cost and schedule. The second JCL model would contain uncertainty and the risk quantified values in their current state. The third JCL model would contain uncertainty and the post mitigated risk quantified values. Results of all three models would be compared once all the analysis simulations are completed. Below are notional screenshots associated with pre and post mitigation results for cost and schedule risk analysis.

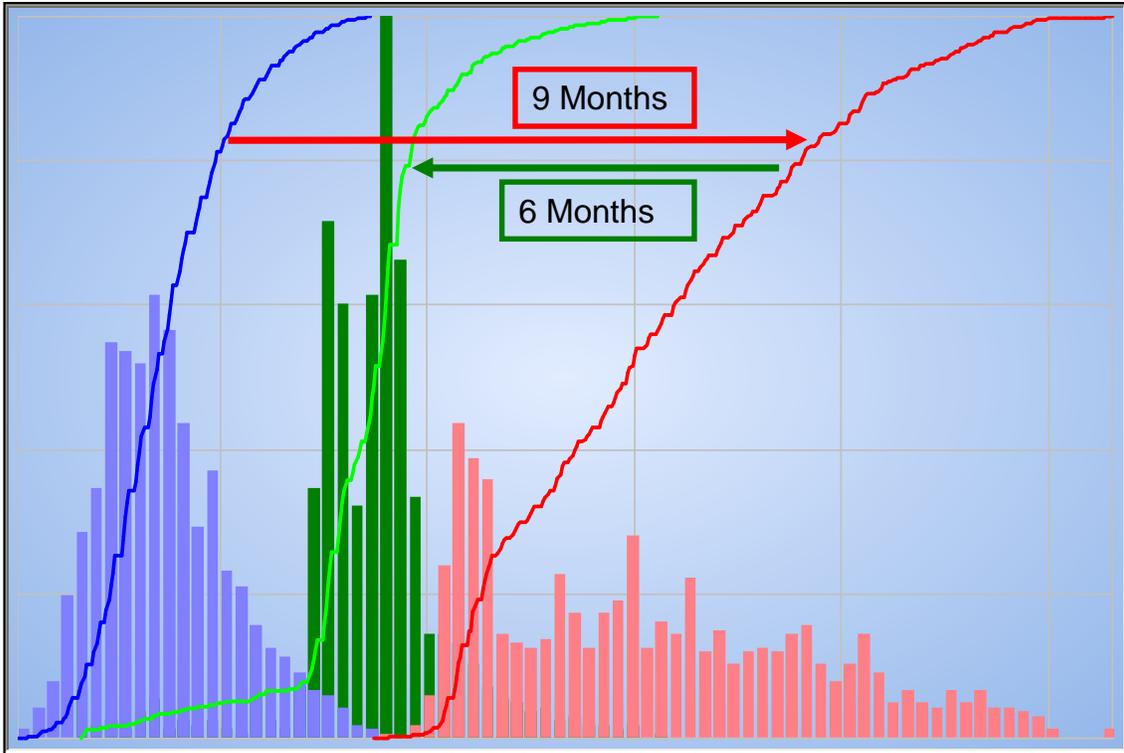
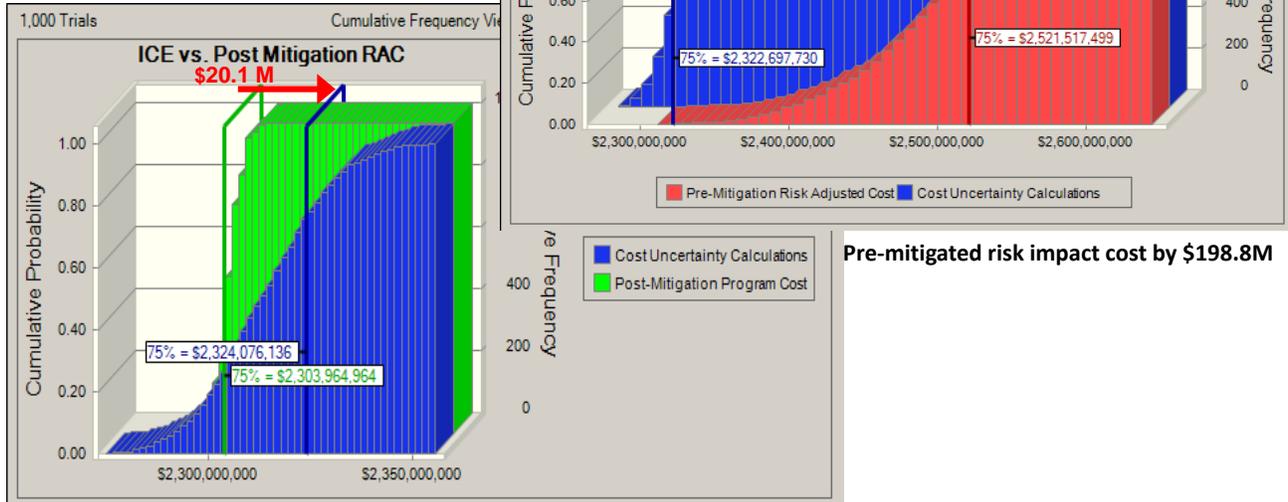


Figure 1 – Mitigation Effectiveness Analysis Results for Schedule
(Blue = Uncertainty only; Red = Uncertainty & Pre-Mitigated Risk; Green = Uncertainty & Post-Mitigated Risk results)

Figure 1 above shows potential schedule growth of nine months due to unsuccessful mitigation of risks and/or issues. The green bars are indicative of successful mitigation efforts and illustrate a project being able to recuperate six months of schedule slip for an overall impact realized being a three month schedule slip.



Successful mitigation efforts reduce potential cost impacts cost by \$178.7M. With a \$20.1M growth incurred from residual risk and mitigation efforts.



Pre-mitigated risk impact cost by \$198.8M

Figure 2 – Mitigation Effectiveness Analysis Results for Cost

(Blue = Uncertainty only; Red = Uncertainty & Pre-Mitigated Risk; Green = Uncertainty & Post-Mitigated Risk results)

Figure 2 represents potential cost impacts from pre-mitigated risks and cost impacts from residual risks, as well mitigation efforts captured within the post-mitigated results. Pre-mitigated results indicate potential cost impacts from risks realized of \$198.8M. The post-mitigated results indicate that \$178.7M of cost impacts could be avoided through successful mitigation efforts. The project would still incur cost growth of \$20.1M mainly due to allocation of resources for mitigation efforts.

By performing this analysis a P/p can then assess effectiveness of successful mitigation efforts. In this case, successful mitigation efforts would net \$178.7M avoidance of cost impacts and 6 months of schedule impacts that could result from realized risks. These results are also viewed at the holistic level of a P/p. A deep-dive assessment should be done by a P/p to look at case-by-case mitigation efforts to determine where best to allocate resources. This is extremely useful for P/p facing constraints with regard to the amount of management reserve that can be applied to mitigation efforts. A deep-dive assessment will provide insight with regard to where the “best bang for the buck” is, targeting key risk drivers and increase effectiveness of resource allocation.



3.0 Conclusion

In conclusion, it is possible for P/p to capture mitigation efforts within a JCL if key steps are taken to ensure the fidelity of results accurately reflect the P/p risk posture. It is imperative for a P/p to take credit for mitigation efforts, all work associated with mitigation tasks must have already been incorporated into a P/p baseline cost and IMS, with clear demonstration mitigation efforts are being proactively tracked and managed. Simply to say a mitigation plan has been outlined is not an adequate reason for reducing likelihood and consequence risk values.

Adequately incorporating risk mitigation efforts into the JCL process can be very beneficial for providing more "realistic" snapshots of the risks and uncertainties facing a P/p on its path to achieving mission success. This does come with caution in that simply incorporating post-mitigated risk ratings into a JCL without having mitigation plans that are well defined, and executable, only provides a false sense of optimism. If a P/p is following NASA NPR 8000.4A, all steps outlined for incorporating post-mitigated risk values into the JCL analysis is already being done under the CRM process.